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AUTHOR Morris, Don R.
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ABSTRACT

This paper outlines reasons why current school improvement efforts in the Miami-Dade (Florida) school district are inadequate and offers an approach that will both build on the formal structure already in place and add a methodology to make it more effective. The text focuses on the field of system dynamics and how this method of analyzing features of complex, interconnected actions can help principals. The narrative examines school-originated improvement efforts and what principals can do to improve their schools, particularly if their schools are among those designated as Low Performing Schools. It looks at the school as an organization and a system and how solutions to problems are apt to be counterintuitive. Suggestions for enhancing the improvement process are offered, and the text outlines how principals can use theory in making decisions in complex systems. It looks at an idealized school-improvement scenario in which objectives guided by research and dynamic analysis might reflect an underlying strategy based on an understanding of a complex process. The scenario illustrates how peer influence, peer-interaction patterns, and group characteristics can affect a school. Overall, the system-dynamic approach offers a sophisticated technology to mobilize local knowledge, expertise, and plans. (Contains 47 references.) (RJM)

A Computer-based Technology to Assist in Developing School Improvement Strategies

Don R. Morris

Miami-Dade County Public Schools

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Don R. Morris
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In the past, business computer models were thought of as technical tools for tightly structured problems of prediction, optimization, or financial planning. But increasingly, models are seen to have a different and more subtle role as *instruments* to support strategic thinking, group discussion, and learning in management teams. In this respect they are quite similar to qualitative problem structuring approaches used by strategy advisers and process consultants.

John D. W. Morecroft, 1994

The mobilization of resources behind the latest effort to improve the performance of the state's public schools is well under way. Optimists will argue that this time around, the magnitude and quality of the school improvement effort is better, more thorough, and extends deeper than in previous attempts, and that may be true. Preparations in the Miami-Dade district seem particularly thorough and well-constructed. Skepticism persists, however, and rumors continue that this current effort is faring no better than those of the past. I am one of those skeptics. In this paper I will give some reasons why I believe that the current effort is inadequate, and offer an approach that will both build on the formal structure already in place, and add a methodology to make it more effective.

Some assumptions I begin with the assumption that the principals of schools, who are expected to carry the main responsibility for school improvement, possess the knowledge and skills to do the job. Specifically, principals are what Charles McClintock has labeled "applied theorists." Speaking of administrators in general, he writes: "Thinking theoretically is what good administrators do . . . . [This implies] the ability to relate information about the ongoing and often disconnected flow of everyday events to underlying concepts of program purpose, process, and structure" (McClintock, 1990, p. 19).

However, the information they have to work with is fragmented, the content complex, and their time for reflection often very limited. Though they are knowledgeable and capable, they are in need of assistance in developing and using the experience and skills they possess. The formal structure already in place for assisting the schools in achieving improvement is very well developed, and it offers an excellent base from which to work, to modify and to expand. It appears to fall short by being too formalistic and mechanical; a consequence not of a failing of the people involved, but of the functioning of the educational system as an institutionalized organization (Morris, 1997). It is argued in this paper that the real culprit is complexity, and that technologies are available that can overcome that obstacle.

The technology One such technology is system dynamics. Here is how the founder of that field sees the problem faced by line administrators:

> [P]eople are sufficiently clear and correct about the reasons for local decision making--they know what information is available and how that information is used in deciding on action. But, people often do not understand correctly what overall behavior will result from the complex interconnections of known local actions. . . . the human mind is not able to deal with the inherent dynamic complexity of such a situation. . . . only computer simulation methods are capable of revealing the behavior implicit in the structure that can be built from knowledge about the many local decision-making individuals and how they are connected. (Forrester, 1991, pp. 9-10)

Forrester goes on to describe the field this way:

> System dynamics combines the theory, methods, and philosophy needed to analyze the behavior of systems in . . . management . . . and other fields. System dynamics provides a common foundation that can be applied wherever we want to understand and influence how things change through time. (p. 5)

The system dynamics technology has been in use since the 1960s in analyzing problems for major corporations and assisting in their solutions. National and local governments have been heavy consumers of the technology (Barney, Kreutzer, & Garrett, 1991), and closer to home, the Educational Testing Service has recently engaged system dynamicists in their planning for the transition from paper-and-pencil testing to computer-based testing (Homer, 1997).

Initially, system dynamics was used to construct large models of whole systems, to project system behavior over large time horizons. There are a few examples of these in educational research: Andersen (1980) on educational finance; Gaynor (1981) on educational leadership; and Morris (1994) on educational reform. However, the trend lately has been to smaller models constructed with the participation of those affected by the problems they are constructed to analyze. There is now a great emphasis on training groups of administrators, and terms such as "learning organization" and "systems thinking" have become key phrases (see for example Senge, 1990). Lane (1994) has described the shift in modeling style away from the traditional expert consultation approach to an emphasis on modeling for learning, and that is my emphasis in this paper.

Attempting Change in a Complex Organization

School-Originated Improvement Efforts

The "Wave 1" reform of the 1980s was "comprised mainly of centralized controls and standards" (Murphy 1990, p. 23). The "top down" reform efforts of the early 80s laid out specific instructions for school personnel, dictated in detail from higher authority, and tied to direct funding. In contrast, the "Wave 2" reform of the 1990s was --in contrast to the former and in reaction to it-- a bottom up reform that championed local, site-based autonomy in reform efforts.

Since the Florida legislation was passed in the early 1990s, many rules, scripts, guidelines, and procedures have been developed to help schools develop plans that will produce "constant improvement" (if they are already performing above the minimum) or get off the low performing list if they are not. The School Improvement Plan (SIP) meetings, the "benchmarking" activities, the elaborate debriefing sessions involving evaluation personnel at the end of the year; all these things are for the purpose of demonstrating that a district has the proper attitude, is doing the

right things, and is "in compliance." Considerable formal structure has been constructed to assist the schools. The state's Office of School Improvement (OSI) and their regional representatives foster and support district level training and guidance to assist schools in preparation of annual School Improvement Plans, with an emphasis on feasibility (Office of School Improvement, 1997). Along with other districts around the state, the Miami-Dade County Public Schools (MDCPS) has developed clear-cut standard routines to assist the schools in making their preparations for improvement (Office of Educational Planning, 1998a).

Schools then develop their own SIPs (for a large number of SIP summaries, concisely displayed, see Office of Educational Planning, 1998b). As an example of a typical SIP objective, one of the average-performing elementary schools in Miami-Dade had 5 objectives listed on its 1997-98 SIP, of which the following was selected at random:

> Students in grade 4 will demonstate growth in major geographic concepts as measured by an increase in test scores from pretest score averages from the September, 1997, administration to the posttest score averages from the May 1998 administration of a school-made geography test.

Of the five, not one referenced any test scores or other data that were not produced at the school, under the complete and exclusive control of school personnel.

Until 1995, all objectives were set by the schools themselves, and the above is an example of a school-determined objective. Most objectives tended to refer to activities and outcomes directly under the control of the school's staff, although some did choose to include objectives referenced to external criteria, such as normed test scores. An *Education Week* special report (Quality Counts, 1997, p. 89) has observed that before Commissioner Brogan introduced his Low Performing Schools (LPS) list, no Florida schools failed two years in a row to meet their stated objectives for improvement. Those principals too naive or straightlaced will not fare well under this approach, but for everyone else it is simply a question of picking things that can safely be undertaken with low probability of failure. It rarely takes more than a year or two to catch on.

The Principals On Their Own

It was because school objectives appeared to be somewhat less than rigorous that Florida Commissioner of Education Frank Brogan introduced the Low Performing Schools (LPS) concept in 1995. Since then, the bottom-up approach to reform has come to look a lot more like the top-down version of the 1980s. With the introduction of the Low Performing Schools List, a mild form of high-stakes testing was reintroduced. This currently takes the following form in Florida: a school is termed "low performing" if, for two consecutive years, it fails to meet 3 criteria, as follows. On two objectives, a normed test reading score and a normed test mathematics score, a minimum of 33% of elementary and 40% of middle students must score above the 50th percentile. On a third, the Florida Writes, 50% fail to score a 3 or better. In 1995, some 158 of Florida's public schools fell into the category of Low Performing Schools.

But the intervention is taken further. Even schools that are not on the LPS list, but are "close to being classified as critically low performing," are required to tie one or more objectives to test score outcomes:

> Schools that are not on the Critically Low Performing List, but that do not achieve the reading, mathematics, and writing levels for the most recent year on the criteria stated in State Board of Education Rule 6A-1.09981, are required to include objective(s) in the School Improvement Plan that stipulate that student performance will meet/or exceed the State's minimum standards in the applicable specific area(s). (Office of Educational Planning, 1998a)

As always, the principal is on the spot, and ultimately on his or her own, to "get the scores up." In just 3 years, the number of Florida schools on the List of Critically Low Performing Schools dropped from 158 to zero. Commissioner Brogan is on record as "surprised but elated by how quickly the list shrank" (Farrell, 1998). With the coming of the FCAT, the stakes will be raised yet again.

A similar sequence of events occurred in the 1980s. Then, much hinged on the scores of the SSAT (a criterion-referenced test constructed specifically for that reform) administered at selected grades. The test results were released to the local press each year, placing considerable pressure on principals to "get the scores up." The percentage of Florida schools scoring below the cut-off on the SSAT in 1977, when the reform began in Florida, was 17.7. The next year it dropped to 5.2, and within four years it had dropped below 1 percent (FDOE, nd, p. iv), a pattern remarkably similar to the one recently observed.

Meyer and Rowan, who are among those who characterize schools as institutionalized organizations, point out that the normal operation of such organizations include activities that supplement the formal rules to avoid embarrassment and keep things running smoothly: "Participants [in the organization] commit themselves to making things work out backstage. [They] engage in informal coordination that, although often formally inappropriate, keeps technical activities running smoothly and avoids public embarrassments" (Meyer & Rowan, 1977, pp. 358-359).

For obvious reasons, evidence of such "formally inappropriate" behavior is scarce. One study did report on reactions in the state of New York to the pressures of high stakes testing. Allington and McGill-Franzen (1992) reported finding a significant increase in the proportion of children identified as handicapped or otherwise removed from the test rosters in a number of elementary schools during a period of high-stakes assessment in the 1980s. One of the authors stated of this research that "In virtually every school reporting substantially improved student achievement . . . the whole of the achievement could be accounted for by these practices" (quoted in Viadero, 1993).

Similarly in Florida, comparable responses to high stakes testing have been widely rumored. Accusations of partial-year retention and promotion-around-the-test in the 1980s accompanied the administration of the SSAT testing. Similar rumors are emerging with respect to the low performing schools of the 1990s. In all such situations, it is the principals who are left out on a limb, alone responsible for "getting the scores up." Despite various efforts to support them, the buck still stops at the school office door, as it always has. Even in the "top down" 1980s, one major study of urban principals found that the district administration supported and encouraged considerable autonomy on the part of principals, but on the condition that they "hold the line" and prevent any conflict or disturbances from disrupting things at the district level (Morris, *et al.*, 1981). And while teacher and parent participation in councils and committees no doubt lends

legitimacy, there is no reason to expect expertise in reform or shared leadership responsibility from such participants. Research over many years has consistently shown that teachers are often reluctant to accept leadership responsiblities (e.g., Duke, Showers, & Imber, 1980; Hanson, Morris, & Collins, 1992), and parent initiative is rarely available where it is most needed, in the failing schools (Boyd & Crowson, 1981). To reiterate, it is the principal who must see to whatever school improvement there is to be.

The School as Organization and System

Tyack and Cuban (1995) write of a "grammar of schooling" that forms a cluster of rules and expectations to which all schools closely adhere. This grammar is very resistant to change:

> The basic grammar of schooling . . . has remained remarkably stable over the decades. . . . even vigorous and imaginative challenges to it tended to fade . . . not fundamentally altering the way schools are organized. . . .The grammar of schooling is a product of history . . . . Established institutional forms come to be understood by educators, students, and the public as necessary features of a "real school." (pp. 85-86)

This description is very close to that of sociologists of the new institutionalist school, and in fact Tyack and Cuban cite several of the better known. Meyer and Rowan (1977), who first identified schools as institutionalized organizations, took note of the dependency that such organizations had on expectations from their environment: "By designing a formal structure that adheres to the prescriptions of myths in the institutional environment, an organization demonstrates that it is acting on collectively valued purposes in a proper and adequate manner." (p. 349). An institutionalized organization results from the inability to show clearcut control over the organization's outcomes. The now orthodox explanation is that of technological ambiguities that do not permit sufficient control over outcomes; ambiguities that are either permanent characteristics, or that at least are not amenable to deliberate change through policy.

If the technology is inherently ambiguous, or if the process conceals the fact that desired outcomes cannot be attained, then there is no alternative to the institutionalization, and the present pattern of a reform cycle that maintains a behavior of forever promising reforms that can never be realized, will continue. One can even argue that this process is "normal" (that is, determined by environmental conditions that occur naturally and cannot be altered).

However, it may also be argued that at least in part, the reason why no reliable change in outcomes has been achieved is that the educational process is an interdependent nonlinear system the working of which is counterintuitive, defying our best efforts to understand it well enough to produce predictable change. If the problem is one of having been in the past unable to understand the complexities of the system well enough to achieve the desired outcomes, then the possiblity of improvement is an achievable goal. Meyer and Rowan held out the possibility of such a move, in the presentation of a spectrum of organizations from outcome-dominated to institutionalized. They also pointed out that the educational system has not always been plagued with such ambiguities of its technology. Both these points hint at the idea that understanding the complexities that are now causing unpredictable outcomes can lead to ways to reduce that unpredictability.

Such an understanding will not come easily. It is extremely difficult to plan for school

improvement or anything else in a complex, unpredictable environment. Studies of executive decision making done by the System Dynamics Group at MIT have probed the problems encountered in complex and dynamic environments, and their research has shown that people have great difficulty in dealing effectively with environments of even moderate complexity (see for example Sterman, 1989). The more complex the environment, the more important a knowledge of the system process is to that understanding.

It is a basic premise of system dynamics that in complex systems the solutions to problems are apt to be counterintuitive. That is, one cannot rely on the kind of intuition we learn from personal experience. In a much quoted article, Forrester (1971) argued that individuals learn from experience to have an intuitive feel for the dynamics of change, but that that experience extends only to simple systems where causes occur in close proximity to results. In more complex systems causes can be very remote from their effects, and the intuition of our experience fails us in trying to respond to those observed effects. It was Forrester's conclusion that the only way to develop a reliable intuition with respect to complex systems was through study of their structure and behavior. And there is really only one way to do that: "simulation is the only known way to determine behavior in complicated nonlinear systems" (1991, p. 13).

Improving the Improvement Process

The Decision Process in a Complex System

Principals as theorists In making the case that administrators apply theory, McClintock (1990) defines the activity: "Applied theorizing uses the logic of science but also validates knowledge against what is contextually and politically sensible" (p. 19). In doing so, administrators must carry in their heads mental constructs, or models, of their environment and how it operates, which they apply to that environment when making decisions.

Forrester (1991) has long emphasized the value of these mental models. He states that when faced with a problem to be solved, the place to start is with the decision makers in the organization: "The first step is to tap the wealth of information that people possess in their heads. The mental data base is a rich source of information about the parts of a system, about the information available at different points in a system, and about the policies being followed in decision making." (p. 5) While fully recognizing that mental data must be elicited with skill and carefully checked against other available data, he maintains that: "In general, the mental data base relating to policy and structure is reliable" (Forrester, 1991, pp. 23-24).

However, these mental models are implicit and rarely exist as systematic and consistent bodies of knowledge. "Mental models are often logically incomplete. Assumed resulting behavior is likely to be contrary to that implied by the assumptions being made about underlying system structure and governing policies" (Forrester, 1991, pp. 15-16). Nor do the problems come in neat bundles waiting for a solution: "Every administrator confronts a daily stream of puzzles and problems, most of which are not structured for easy analysis and solution. Administrative work is fragmented into diverse, short episodes of information exchange" (McClintock, 1990, p. 22).

And as members of a service industry which exhibits the characteristics of an institutionalized organization, school principals also face a problem that the average business executive does not: "A critical part of applied theorizing consists of knowledge of the organization's production or service delivery *process*. . . . Especially in service organizations, this knowledge often is based on implicit models of causal processes that are not well understood. . . . these models often rely on uncodified experiential knowledge that makes it difficult to share and apply professional wisdom in a particular situation" (McClintock, 1990, pp. 20-21, italics added).

As applied theorists, then, Florida's school principals are potentially more than capable of coping with the challenge of school improvement, but there are obstacles to be overcome: "Complex systems defy intuitive solutions. . . . Attempts to deal with nonlinear dynamic systems, using ordinary processes of description and debate, lead to internal inconsistencies" (Forrester, 1991, p. 19). In order to achieve school improvement, principals need to be provided with the right preparation and resources.

A structured process Vennix, et al. (1994) note that "A rich body of theoretical and experimental work already exists on how to elicit and map qualitative knowledge that resides in the mental models of individuals and groups" (p. 45). Interested readers should see this work for a review of that literature. If the approach to working with those mental models is system dynamics, a mathematical model will have been constructed, either prior to the group discussion and modified by it, or as an iterative, ongoing part of the process. There are a number of good and recent technical introductions to system dynamics modeling (Hannon & Ruth, 1994; Eberlein, 1996; Richmond & Peterson, 1996).

For purposes of this paper, I will describe one way that the technology might be applied, adapted from Vennix and Gubbels (1994).[1] Given a selected problem, a small project group, one or two persons from the firm seeking to solve the problem, and one or two technical people (modelers), design a preliminary model, which is based on available literature and insights within the group.

From this model, a questionnaire is developed. The questionnaire is divided into sections, or item sets, each reflecting an important outcome concerning the problem as modeled. These sections each consist of a series of statements representing a bivariate relationship, where section topic is considered as the dependent variable, to be paired with a series of independent variables in statements of relationships. An item might read:

> "The larger the initial size of the group of high-achieving students, the greater the increase in overall achievement during the school year."

Respondents are asked to agree or disagree on a 4-point Likert scale. In addition, the questionnaire seeks to uncover causal arguments from respondents' mental models, especially those not covered by the items. For this reason they are asked to indicate why they agree or disagree with each item, and at the end of each section, the respondents are asked to add any variables that they perceive to affect the dependent variable. Finally, each respondent is asked to identify the three variables considered to have the greatest impact on the dependent variable.

A fairly large number of experts (persons considered knowledgeable with respect to the problem

modeled) are then to be sent the questionnaire (Vennix and Gubbels used 60, with a 90 percent return rate).

Based on the returns of the questionnaire, a workbook is constructed, which allows those using it to concentrate on sets of interrelated variables instead of the simple bivariate relationships of the questionnaire. This workbook is then given to a subset of the group receiving the questionnaire (Vennix and Gubbels used 18 of their original 60). The workbook serves to prepare this subgroup for a structured workshop in which the variable relationships, which constituted subsections of the original model, are discussed and modified. (There were actually 2 workshops of 9 participants each, lasting 3 and one-half hours apiece, in the Vennix and Gubbels study.)

The purpose to this point is to obtain a consensus and eliminate disagreement with respect to the model. The final model is then available to local groups for experimentation, each player choosing settings similar to his or her own school, observing model behavior, and meeting in groups to discuss the outcomes and plan how best to choose strategies that will yield success. From these activities should come the strategies, operationalized by tactical objectives that will be adopted for implementation.

An Idealized School Improvement Scenario

In 1991 Richard Elmore commented that:

> [T]here doesn't seem to be much cumulative learning from one cycle of innovation [i.e., reform] to the next. . . . This "treadmill effect" occurs despite the fact that social science knowledge around subjects like human motivation, job satisfaction, and performance is arguably becoming progressively more sophisticated over time. . . . [This situation is] likely due to the fact that new knowledge, such as it is, doesn't enter into the considerations of innovators. (pp. 29-30)

With this comment in mind, consider a typical SIP objective for an average middle school. It might read:

> Given an emphasis on reading instruction, over 40 percent of eighth graders will score above the 50th percentile on the reading comprehension subtest of the Stanford Achievement Test in the 1999 testing session.

As Miami-Dade's SIP manual recommends, the how, who, what, and when are all concretely specified (Office of Educational Planning, 1998a). The objective serves its purpose of committing the school to the outcome. In effect, it says that "these students' scores will go up because we will concentrate our efforts and work harder." Any person on the street (or any legislator) could have written the equivalent. It reflects no expertise or understanding of what is involved in actually bringing the outcome to realization.

By way of contrast, what follows is a scenario in which objectives guided by research and dynamic analysis might reflect an underlying strategy based on an understanding of a complex process. It will first be necessary to set up a situation, drawing on the research literature, that is cast in terms of feedback and the resulting nonlinearities.

The situation to be modeled Increasingly, greater emphasis is being placed on the role of peers and peer influence in learning, most recently at the expense of parent influence (Harris, 1995).

Peer influence is now posed as a critical variable in explaining chronic student underperformance, particularly in the middle grades (Urdan & Maehr, 1995). Recently, much of the literature on repeated failure has been reporting a feedback loop of reciprocal causation among a selected group of variables in producing and sustaining student failure. Straits (1987), for example, cites several studies which show that "age-grade retardation is a cumulative or snowballing process" (p. 40). Weishaw and Peng (1993) list a dozen references of research between 1960 and 1990 that "suggest a reciprocal causal relationship between achievement and behavior" (p. 5). Kohn (1994) has noted that "Some [researchers] say that self-esteem and achievement are causally related .... [and] some writers insist that the relationship is reciprocal, with self-esteem and academic achievement each affecting the other" (p. 275). Kaplan, Peck, and Kaplan (1994) constructed a structural model and reported that "The causal chain whereby early school failure leads to feelings of self-rejection in the school environment ..., which in turn influence disposition to deviance ..., which itself influences academic failure ..., found strong support in this analysis" (p. 169).

The next step is to tie these student level feedback loops to peer interaction patterns. Urdan and Maehr (1995) described the reciprocal interaction of many of the variables related to academic failure in a dynamic scenario. They wrote:

> [A] student that begins to experience failure in school . . . may begin to develop negative attitudes about schoolwork and exert less effort in school. On the basis of these attitudes, the student may select a friend with similarly negative feelings and attitudes toward school, and these two students can reinforce and strengthen each other's negative orientations toward academic achievement. . . . Over time, these attitudes may lead to sustained underachieving behavior, which in turn might cause these students to be placed in a low-ability track with other peers who have negative orientations toward school and school work. In this case, academic failure (an antecedent) leads to the social goal of seeking approval from a negatively oriented peer, which leads to increased negativity toward school and even lower achievement (a consequence). This consequence, in turn, leads to the additional antecedent of being surrounded by negatively oriented peers, and a cyclical pattern of causes and effects is created. (p. 231)

Some years earlier, Campbell and Alexander (1977) had proposed a model in which they hypothesized that individuals are more likely to exhibit more motivation for achievement, where there is greater opportunity to strike up friendships with others who are highly motivated.[2] They were able to show that the hypothesis was empirically supported. The idea is that aspiration to achieve (academically), is presumed to stem from the exponential increase of possible contacts with high achievers available to students attending a given district's schools, as the number of high achievers increases at a linear rate. Bluntly put, as the SES of a school increases additively, the aspiration to achieve tends to increase exponentially, provided that all members can interact without inhibition.

This relationship applies of course, not only to friends of high status, but to friends of low status, friends who frequently misbehave, and so on. Urdan and Maehr (1995) also extrapolated to the school level:

> Most researchers now assume that peers can have either a negative or a positive influence on adolescents' attitudes and behavior. In particular, peers can either encourage adolescents to view their school experiences positively, or encourage them to see school as an uninteresting or hostile place. The outcomes for any specific adolescent depend on the characteristics of the peers with whom the adolescent spends most of his or her time. (Berndt & Keefe, quoted in Urdan & Maehr, 1995, p. 220)

Thus there are two "core" groups--high achievers and low achievers--with very different attitudes and behaviors occurring together in every school, in varying proportions. The important thing to note is that interactions with members of these groups generate positive feedback loops, and that positive feedback loops produce change at an exponential rate. When students are free to interact with a minimum of predetermined restrictions (as in the first year of middle school), the feedback loops result in rapid, non-linear growth in one or both of the core groups, such that for high and low SES schools, the already larger core tends to grow disproportionately. In the mid-SES range, where the groups are more equally matched, one or the other group tends to gain and hold dominance in any given year, the result of random factors.

The simulation process A model has been constructed that simulates the effects described in the preceding section.[3] It is based on a mathematical concept, described by Arthur (1990), in which positive feedback loops determine which of several competing products introduced into a market will come to dominate it. There are two variables that are subject to the user's manipulations: SES and what I will call "school culture."

The model is based on a number of assumptions. Enrollments are made up of two general groups of students-- those at risk of failure, and those who are not. Those students of low SES are more prone to be at risk than are those of high SES. In the model SES is operationalized as the percent of students eligible for Free or Reduced-price Lunch (FRL). This is a figure most administrators are familiar with, and know the value of for their particular school. The size of the at-risk group is computed as a linear function of FRL. The not-at-risk group is simply the remainder.

Of the two general groups, perhaps 20 percent of each consists of those who repeatedly fail (among the at-risk), and those who consistently excel academically (among the not-at-risk). These 20 percent subgroups of students are the cores to which others of their respective groups may be drawn through unrestricted random encounters. To the degree that the school's culture is weak, these cores attract others of their larger group to them, where they remain for the rest of the year.

A school's "culture" may be thought of as its "established way of doing things." The experience of entering a new school and encountering new and unfamiliar expectations is disruptive to established routines, and encourages individuals to seek cues and guidelines for their behavior somewhere other than the usual rules, as for example from peers. The school culture at the beginning of middle school is weak, for example. This can be inferred from the sharp rise in disruptive behavior and retentions, and from the sharp drop in test scores and self-esteem measures, as reported by many observers (for a survey of the literature see Anderman & Maehr, 1994).

The model opens to a panel for making and observing model runs. Two dials allow the values for FRL and School Culture to be set before a run, and two graphs permit the outcome of the setting of the culture dial to be compared with a baseline graph representing a "strong culture" outcome for the model settings subjected to identical random variations. The strong culture represented in the baseline graph maintains the cores of the groups at approximately the same size throughout the school year as when the groups entered. The culture dial settings give an indication of how much in the way of resources may be necessary to achieve the degree of

cultural strength desired.

A key assumption is that a new culture, in the sense of "an established way of doing things," can be defined and/or strengthened intentionally, by policy, by defining clearcut rules at the outset for incoming new students, and then enforcing them firmly until they become a part of the collective behavior. Such a culture is then expected to carry over year after year for the same institution.

The FRL dial gives users of the model an immediate way to enter the value for the school of interest. The dial has settings varying from 0 to 1 in increments of 0.1. The FRL setting determines the relative sizes of the general groups. In turn, the relative sizes of the cores, arbitrarily set to 20 percent of the general groups' sizes, are also determined by the FRL setting. The size of the dominant general group's core tends to increase exponentially in model runs as the general group size increases additively ("tends" because the outcome of each run is the product of random variables). In the middle of the FRL range, the at-risk and not-at-risk cores are about equally likely to dominate on any given run, and for a rather wide range about the 50 percent FRL point, an alternation of domination by both cores is frequently observed. This poses some interesting situations for the making of improvement strategies.

The Culture dial has settings varying from 50 to 1000, in increments of 50. The initial culture setting is set to 50, the weakest level, simulating the assumed condition at the beginning of the first middle school grade. At the highest setting, the culture variable on the right or experimental graph equals that on the left, baseline graph.

The user of the model sets the FRL dial for an individual school and then initially investigates the effect of the weakest culture setting, observing the comparative results, as often as desired. (The general group and core affiliation variables are random and yield different results each time, characteristic of variations within the bounds of the particular settings.) He or she can then vary the "strength" of the culture and run again, repeating the runs at each culture setting until satisfied that the behavior of the cores at that culture level is understood. The experimentation is continued until a satisfactory level of culture is reached. A decision of what culture level is feasible is the user's judgment call balancing the degree of culture strength achieved against the resources required to achieve that level. An increase of the dial from 50 to 150 say, indicates a threefold increase in the effort expended to achieve the higher level.

How simulation results might alter the stating of objectives Let us assume that a group of principals have participated in a process (conference, workshops) in which the just-described model was produced and/or modified to its present form, with their participation and agreement. The model thus reflects a consensus of their collective judgment about the dynamic process it represents. The principals then proceed to draw upon it in planning their strategies of improvement.

Given this assumption, consider how use of the foregoing model might affect the formulation and implementation of an improvement process. Further assume that all principals have the aim of improving their respective schools, with respect to the same specific goal, but that they represent different types of schools. The goal would be: All 8th grade students (or within 5 percent of all, or something similar) will read at or above the 50th percentile. A "general objective" might read: Forty percent of 8th grade students will score above the 50th percentile, or

there will be a 5 (or 10 or 20) percent reduction in the number scoring beneath the 50th percentile, whichever results in the fewest students under the 50th percentile.

This is a permanent objective applying to all schools, and it is "self adjusting." It differs from the goal in that the goal states the ideal, whereas the general objective specifies a minimum to be maintained at worst, to be exceeded if possible. Although the general objective is the same for all, its achievement by schools with different cultures requires different strategies, and so it cannot contain a "how" phrase that is meaningful. The general objective will need to be accompanied by one or more tactical sub-objectives that implement the strategy.

There are likely to be pronounced differences between what we are accustomed to seeing stated as objectives, and the tactical objectives that result from an analysis of the model output. In particular, the "who" and "when" will change. First, there is likely to be a discrepancy between the grade identified in the general objective (8th) and the grade targeted for action. Applied to middle school, improvement at any grade depends on resolving problems related to chronic student failure at the first grade of the level. Second, it will likely take several years to achieve the general objective, since the first year cohort goes on to contribute to the starting culture for the next 2 years.

Third, tactical objectives will differ in substance by percent FRL. Near the ends of the FRL range, growth in the smaller core is negative and limited, while the larger grows rapidly and out of proportion. Consequently, a low FRL levels, the principal may want a "no restrictions" policy, while in the high FRL range, she may want a very strong set of controls on interactions applying across the board. In the middle of the range, the growth rates can be stabilized with a modest expenditure of resources, but this will as often as not suppress the growth of the achieving core; a selective policy may be best here, the "normal" approach of firm rules with rewards.

A final observation--I am aware that some will find the foregoing scenario persuasive and some will not. It is prudent to stress that it is the methodology and not the substance that is relevant here. Even proponents may come to disagree with the some or many of the assertions underlying the model. That is all to the good. Models need to be revised or replaced, based on experience. The process is iterative and never-ending. At the end of each school year, the group should meet again, reporting successes and failures, and revising for better models.

Discussion

Institutional organization theory presently affords a good description of the way a school system operates. It fits because there is no known way to do what the reformers (who control the resources) demand be done. The answer has been to go through the motions of "showing progress" until the next reform provides an alternative that permits the current one to be abandoned (see Morris, 1996). For administrators in education, the system dynamics approach promises an alternative. It offers a sophisticated technology to mobilize local knowledge, expertise, and plans, and adds the insight into complexity that is now lacking, and that is clearly (from past experience) needed if any successful reform is to be accomplished. Acquiring and using it, however, brings challenges and problems.

System Dynamics as a Tool for Administrators

As Morecroft (1994) has pointed out, "The theory of dynamical system models is quite intricate and so . . . is unsuitable for direct use by management teams" (p. 15). If the approach is so difficult, why use the models? There are many approaches other than system dynamics available, that make use of the group discussion and thought organizing techniques. There are system dynamicists who rely heavily on the symbols (feedback loops and flow diagrams) of the technology, and "systems thinking," to work with client groups (see Wolstenholme & Coyle, 1983; Senge, 1990).

Forrester (1991) has pointed out that even "systems thinking" approaches only provide "a transition from non-systemic thought processes to the field of system dynamics. The necessary further step, after becoming aware of systems, leads into system dynamics and introduces computerized simulation models to provide the discipline needed to help the unaided thought processes from arriving at fallacious conclusions about dynamic behavior" (p. 15). Management teams can use diagrams of policy functions to identify actors in a business system and specify their policy functions, and then later on use policy maps, frameworks, and simulations.

An Emerging New Role?

It is McClintock's opinion that "To be most effective, those who assist administrators in developing and improving organizations . . . should orient their work toward the task of applied theorizing. . . . Theorizing as learning involves an ongoing dialogue between assumptions and expectations and the evidence that is gathered" (McClintock, 1990, p. 20).

How problems are posed is crucial to the output of groups of administrators. Such groups must be led (or somehow kept on task) by some person or persons who knows: 1) the related basic research applying to the problem to be modeled; 2) the methodology that will be applied, well enough to know how the answers provided must be cast; 3) the relevant specifics of the district; and the skills of group interaction. Morecroft (1994) has noted the need for both technicians (modelers), and for facilitators to translate between technical people and the management team (see p. 21). The skills differ, and both technically sophisticated modeling skills and the ability to interpret these to the management team and draw them into debate and discussion of structure and scenarios, are needed. Vennix, et al (1994) also note the need for both, and observe that the two roles are not necessarily filled by the same individuals.

How might these roles be filled? Although administrators know a great deal, both as practical theorists and as planners, they cannot be expected to have either the time or the background to be able to deal with formal or abstract concepts. Furthermore, it is unreasonable to expect academic researchers to have the time, patience, or interest to participate in such group meetings. Consequently, many of the people in what are now evaluator roles will probably be expected to adapt to these roles. This involves possessing both technical skills of modeling and group management techniques. (Statistics alone won't do, and is often peripheral, as Forrester has noted.) In addition, a broad knowledge of social science research in general, and educational research as a sub-category in particular, seems necessary.

Problems and Obstacles

System dynamics has been proven many times in practice, but it is difficult to teach (see Coyle, 1996), and few U. S. institutions offer it for formal study. Consequently, skilled practitioners are scarce. The time and money for startup could be burdensome.

Moreover, to use system dynamics in a decision making process, great care must be taken to involve the decision makers in the technology, building upon their knowledge and perceptions: "A system dynamics model, if it is to be effective, must communicate with and modify the prior mental models. Only people's beliefs, that is, their mental models, will determine action. Computer models must relate to and improve mental models if the computer models are to fill an effective role" (Forrester, 1991, pp. 20). For this reason there is no alternative to gathering principals together for participation.

In the face of such demands, there may be little incentive for districts to do this on their own. The educational system as it now operates (institutionalized scripts for enacting detailed routines) works fine in the sense of keeping resources flowing. In fact, the institutionalist "solution" can prove very lucrative for a district, as money is poured in to set up and assist in the improvement procedures. This is one reason the status quo is so hard to change.

So, some combination of state funding and an agency of skilled "roving modelers" may be the most feasible approach. This might perhaps be feasible in the light of the research of Vennix and Gubbels (1994), who report the successful use of a questionnaire approach to a large nominal group to elicit knowledge of causal relationships, followed by a smaller structured focus group to assemble the results into a body of applicable concepts, and finally highly structured workshops for the most involved and promising administrators.

If the obstacles can be overcome, then it may be possible to produce a generation of school principals that is capable of actually bringing together the benefits of research and their own collective practical experience in the interests of genuine school improvement. And the door swings both ways. The structured, detailed knowledge of groups of experienced administrators should contribute substantially to the building of academic theories. System dynamicists are quick to emphasize that the mental models of decision makers are an important source of information: "They point out that [those who confine] themselves to the narrow part of the spectrum consisting of social statistics, which contain no information about the operating policies, goals, fears, or expectations in the system, are hopelessly restricted in learning about how social systems work" (Meadows, 1980, p. 51). Hopefully, the applied and basic approaches to research will reinforce each other in a fast growing positive feedback loop.

Notes

Author's note: The work reported in this paper is not related to my duties for the Miami-Dade County Public Schools, and the district bears no responsibility for the contents. Comments may be directed to donr.morris@worldnet.att.net.

[1]I have summarized Vennix and Gubbels's description of their process and in adapting it, stripped it of its substantive content for my purposes here. The reader wishing to follow or adapt their methods for themselves will need to consult the original article, which supplies considerable detail.

[2] Methodologically, Campbell and Alexander made the leap from the individual to the social level by positing a two-step model of causal inference:

> This [two-step model] involves, first, social-psychological theory, which deals with the individual's response to a *given* social situation, and, second, theory at the structural level, which deals with the determination of that given social situation by characteristics of the larger social system. We must keep in mind the fact that the actor responds to that segment of the total system which, for him, is perceptually important and salient; rarely does he (inter-) act with reference to the system as a whole. (p. 19, emphasis in original)

[3] The model described in this paper, and brought to the presentation, has been modified for demonstration purposes. It has been simplified and shortened so that the outcomes are easy to interpret and quick to run.

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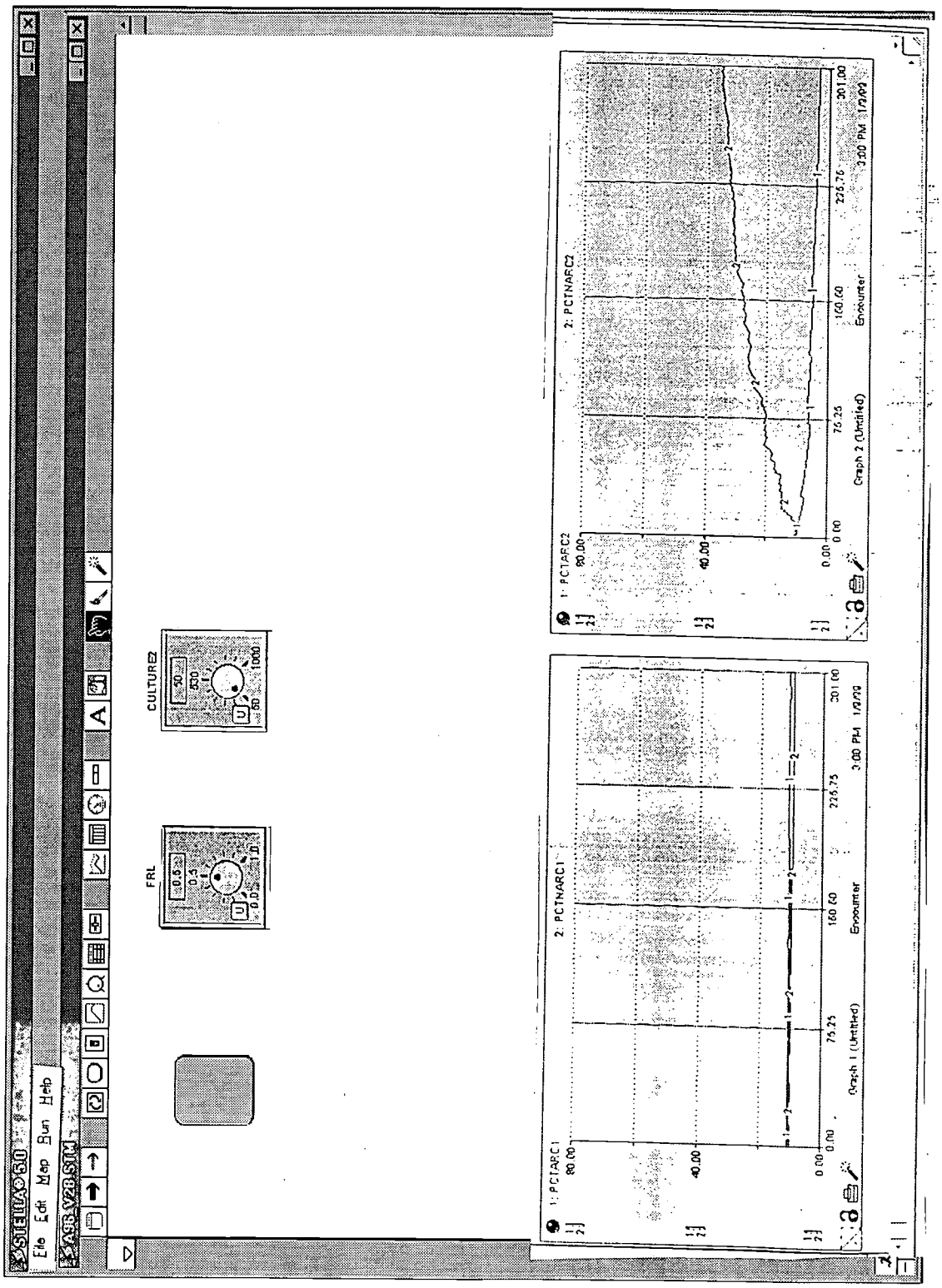
Appendix
Control Panel for the Model



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